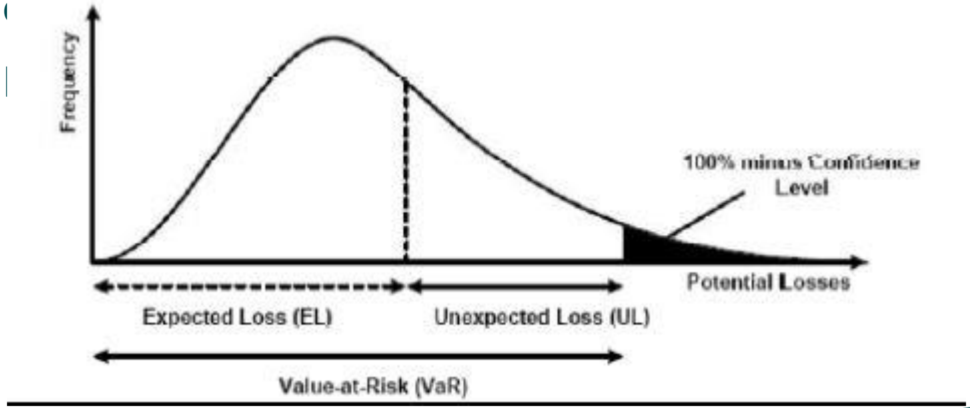
Parametric Value at Risk

Parametric VaR

Value at Risk (VaR) Definition

- VaR is defined as the potential change in market value over a 1-day period at the 99% confidence level due to changes in risk factors.
- The maximum likely loss on a portfolio for a given probability



Parametric VaR

Value at Risk Pros & Cons

- Pros
  - Regulatory measurement for market risk
  - Objective assessment
  - Intuition and clear interpretation
  - Consistent and flexible measurement
- Cons
  - Doesn’t measure risk beyond the confidence level: tail risk
  - Non sub-additive

Parametric VaR

Three Value at Risk Approaches

- Parametric Value at Risk
- Historical Value at Risk
- Monte Carlo Value at Risk

Parametric VaR

Parametric Value at Risk

- Assumption
  - Asset returns follow normal distribution
- Pros
  - Fast and simple calculation
  - Intuitive
- Cons
  - Poor accuracy for non-linear products
  - Second order approximation
  - Hard to incorporate stress test

Parametric VaR

Parametric Value at Risk Methodology

- Assuming an asset return/valueChange follows normal distribution, the quantile of 99% confidence level is 2.326σ where σ is standard derivation
- If absolute return $X_1 - X_0$ is normally distributed, the 99% worse change of X is $X_1 - X_0 = 2.326\sigma$
- The VaR is given by $VaR = \frac{\partial F}{\partial X}\Delta X = \frac{\partial F}{\partial X} \times 2.326 \times \sigma$ where $\frac{\partial F}{\partial X}$ is the delta
- Similarly for a relative return $\frac{X_1 - X_0}{X_0}$, the VaR can be expressed as

$$VaR = \frac{\partial F}{\partial X}\Delta X = \frac{\partial F}{\partial X}(X_1 - X_o) = \frac{\partial F}{\partial X} \times X_0 \times 2.326\sigma$$

Parametric VaR

Parametric Value at Risk Implementation

- For each asset/instrument/riskFactor, calibrate volatility σ_i based on daily return
- For each risk factor pair, calibrate correlation ρ_{ij}
- Calculate the variance of a portfolio value change

$$V_p^2 = \begin{bmatrix} \Delta(P_1)\sigma_1 & \cdots & \Delta(P_n)\sigma_n \end{bmatrix} \begin{bmatrix} \rho_{11} & \cdots & \rho_{1n} \\ \vdots & & \vdots \\ \rho_{n1} & \cdots & \rho_{nn} \end{bmatrix} \begin{bmatrix} \Delta(P_1)\sigma_1 \\ \vdots \\ \Delta(P_n)\sigma_n \end{bmatrix}$$

- The portfolio VaR is $2.326\sqrt{V_p^2}$

Parametric Value at Risk Implementation

- Calculate VaR values by multiplying the net PV01 values for each rating by the credit spread volatility factors for that rating. The credit spread volatility factor is the 1-day movement at the 99% confidence level based on the 2-year credit spread for a particular rating band.

Reference:

https://finpricing.com/aboutus.html